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REGULATING INDUSTRIAL WASTEWATER DISCHARGED TO PUBLIC WASTEWATER TREATMENT PLANTS – A CONCEPTUAL APPROACH

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ABSTRACT

The paper describes some of the basic principles behind the DEPA Guidelines for discharge of industrial wastewater to public sewers set in operation in 1995 and evaluates some of the experiences with the implementation.

It is described how such guidelines support the approach of pollution prevention and the implementation of cleaner technology by putting a stress on the industry. Further an approach for the balance between environmental and technological considerations is introduced.

The need for easily understandable environmental priorities is stressed and a concept for this is presented along with its combination with available technology. Finally expression of the environmental requirements are discussed in relation to environmental and technological considerations. © 1997 IAWQ. Published by Elsevier Science Ltd

KEYWORDS

Industrial wastewater; guidelines; standards; pollution prevention; cleaner technology.

INTRODUCTION

For centralised wastewater treatment plants for mixed household and industrial wastewater, managing the interactions between sources and treatment plant becomes a key issue for successful operation of the treatment plant. Especially the contribution from industry must be regulated properly in order to avoid operational problems at the central treatment plant and transfer of toxic or persistent substances to end up in the effluent or sludge.

The regulatory framework for discharge of wastewater to the public treatment plant has a key role in determining the range of discharges where industries can feel safe that they do not harm the treatment plant and the environment. In a way it works as a sort of declaration of the wastewater discharged. The framework

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sends a signal from the treatment plant to the industries defining the scope of legal action. Further the regulatory framework is a way to compile knowledge of the aspects to be considered.
In situations where industry and treatment plant do not communicate directly - as it is often the case in Denmark - the regulations are an important tool for the local authorities who are responsible for the permit - on behalf of the treatment plant.

This paper presents and discusses some of the considerations to be included in the definition of a regulatory framework for discharge of industrial wastewater to public treatment plant. Naturally most of these principles apply also for common treatment plant's e.g. in an industrial complex.

BASIC CONSIDERATIONS

At the political or organisational level a number of basic - and important - questions have to be answered. These questions includes:

- Shall regulation be performed at centralised or decentralised level?
- Shall industrial discharges be regulated through individual permits or general standards?
- Shall general standards/recommendations or standards for individual types of industries be developed?

Finally it must be considered how the regulatory work can stimulate pollution prevention and implementation of cleaner technology in the industry considered.

Most of the answers to these questions will be determined by tradition or by the political situation but nevertheless a few comments will be made below.

Centralised or decentralised regulation?

Should government based authorities or other central institutions supply standards or recommendations, or should local authorities be completely free to choose the principles for regulation?

The answer depends on the technical ability of the local administration - big or small - and the level of independence.

It is often claimed that the local authorities may be influenced by political pressure and in that way be disqualified to make an un-biased decision. On the other hand this might be the political wish that the local economic situation is included in the considerations. Further, in many countries the local authorities will often be responsible for the treatment plant in consideration and therefore feel the consequences of insufficient control themselves!

In Denmark the local authorities - the municipalities - have for many years been responsible for the discharge of wastewater to the public treatment plants, but until recently with insufficient guidelines. This situation in fact forced the municipalities to make their own individual guidelines, and in order to support each other in the arguments against industry, they worked together in attempts to adjust the individual guidelines to a more general practice. A similar situation was seen in Sweden where the union of water treatment operators (VAV) developed such a set of guidelines as early as 1983.

This illustrates that the municipalities felt a need for a set of common guidelines.

Individual permits or general standards?

Whether to implement a system with general standards or a system with individual permits and guidelines is basically a question of ambitions and available resources. Preparation of a permit with individual requirements for each industry requires a sufficiently skilled staff with the ability to go into negotiations with the industry in question and the necessary back-up organisation to support the individual case officer.

General standards are often claimed to be more easy to control and less resource-consuming for the authorities. On the other hand they may lead to sub-optimisation of the 'industry - pretreatment - treatment plant complex' due to rigid formulation and enforcement of the standards.

In principle individual permits put a more efficient pressure on the industries due to the possibility to adjust the requirements more often - see figure 1. But as already mentioned, the effect of this principle depends on the available resources and the intensity of the follow-up by the authorities.

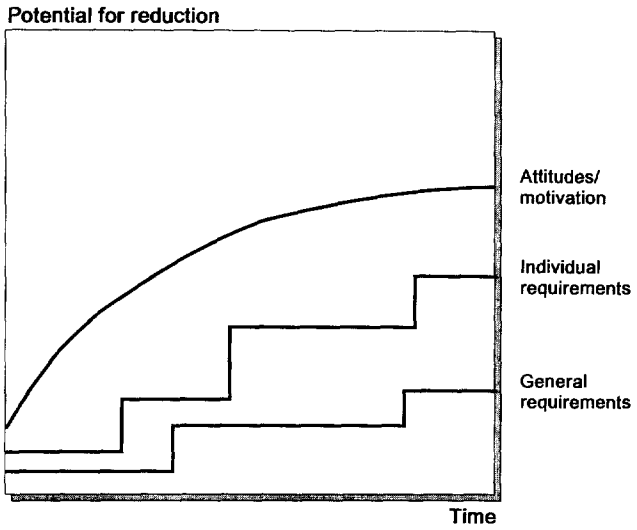

Figure 1. Schematic illustration of the potential for reduction in relation to different form of regulation.

In Denmark individual permits for the discharge of industrial wastewater to the public sewer system are used as the basic principle, but - as mentioned above - a need to prepare common guidelines expressing the principles for assessment of the wastewater and recommendations on how to prepare the permits was identified by the Danish EPA (DEPA) in 1992. The principles for development of these guidelines are further described below (and in Grüttner *et al.*, 1994).

General standards or branch-oriented standards?

Another basic question concerns general standards/recommendations or standards for individual types of industries. The answer to this question may be found in considerations on how to combine the environmental consideration with the technological possibilities.

Since general standards are to apply for all kinds of industries they cannot include technical considerations. One might go even further and say that general standards are needed to express or 'translate' the environmental concern into easy understandable figures. Assessment of industrial discharges to treatment plant is a complex issue where the individual treatment plant may not possess sufficient knowledge. For that reason it might be relevant to supply information on the priorities in a relatively simple way.

Preparation of technology based standards will most often be based on surveys of existing industries with the least polluting being named as 'best available technology' (BAT or BATNEEC). This implies that no assessment of environmental aspects is directly involved and hence the need for general environmentally based standards is obvious - to compare with the technically based standards. Branch specific standards might include environmental considerations balanced against the technological considerations. The problem

is that it is often not possible to identify the basic criteria for the figures, and one might get the feeling that in most cases these figures are based on negotiation rather than facts.

How to stimulate preventive measures/cleaner technology?

Evaluation of attempts to introduce the concept of cleaner technology to Danish Enterprises has shown that there are a number of barriers to overcome (Teknologinævnet, 1992). These barriers include:

Economic barriers:
- lack of money to test or buy new production facilities.

Knowledge based barriers:
- lack of man-power or engineering resources in many small and medium sized industries and
- lack of knowledge of the technological possibilities in particular within the same group of industries.

Attitudinal barriers:
- tradition or conservatism including the unwillingness to run any risks.

Further technological barriers will always exist and institutional barriers e.g. like rigid enforcement of standards might force the enterprises to consider the more traditional end of pipe solutions.

In addition to these aspects, lack of knowledge of the environmental priorities may lead to resignation or resistance against environmental matters in general. Common statements like 'Let us wait until the local authority tells us what to do' shows that the enterprises bears no responsibility for their discharge.

Furthermore these studies have shown that the most important trickling factors - pushing the enterprises over the initial barriers - are:

- demands from authorities,
- improved knowledge of technological possibilities,
- obvious potential to save money and
- generally improved level of environmental concern.

In relation to regulation of wastewater discharge to public treatment plants two main lessons can be learnt from these conclusions:

1) Environmental demands - as expressed in a standard or permit - may stimulate the industry to implement cleaner technology in the production - if expressed in a proper way.

2) Environmental priorities must be expressed in an easily understandable way.

The first statement further implies that it is important to have environmental demands for industries discharging to public sewers, and that these demands are enforced in a way that proves to the industries that the authorities are serious and competent. In a situation with individual permits - as in Denmark - this will actually mean that there will have to be a certain set of minimum requirements for ability and skills to be fulfilled by all authorities in order not to erode this driving force.

It is often useful to realise that the emissions from industry originate from three different kinds of activities:

- the process,
- the equipments including supporting equipment and chemicals, and
- the operation.

Basically the process determines the production of waste materials or by-products from the production, while the equipment and the operation give rise to 'spills' and 'loss' of materials. In the dialogue between authorities and industry, Danish experience shows a tendency to focus on the process and the equipment, but it is important to remember the 'operation' since in many cases significant emissions can be controlled by this type. Much wastewater is produced by cleaning operations and this activity can be done in many ways.

One way to put a stress on the potential for 'good housekeeping' is by emissions-requirements or limit values giving the signal that certain substances should be reduced to a very low level in the discharge.

For this reason some of the limit-values in the DEPA Guidelines are fixed as a sort of 'water quality objective' telling what level of concentration must be reached before no more attempt will be made by the authorities to force the industry to reduce further. As illustrated in Figure 2 most industries will have a potential to reduce the emissions further. By traditional technology based standards only the most polluting will be forced to realise this potential, while by the 'water quality objective' all the industries above the 'target values' will have a stress to reduce further. Naturally such an approach can only operate in a system with individual requirements.

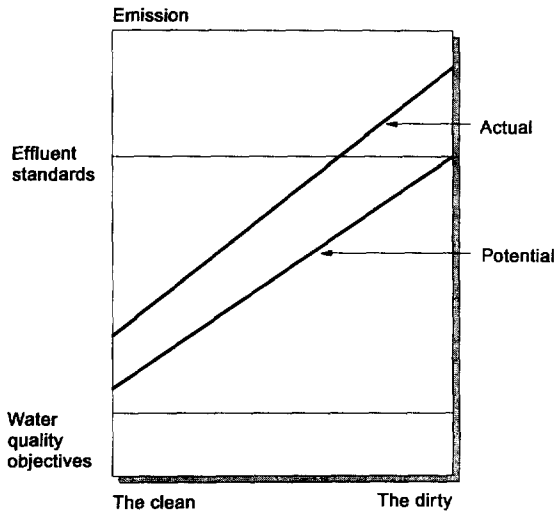

Figure 2. Illustration of how the water quality objectives stimulates reduction in all industries.

The statement that environmental priorities must be expressed in an easily understandable way has been included in the Danish guidelines in the way that all substances can be placed into three groups:

A: Substances that should not be accepted in the sewer system and hence should be reduced by all means. This group includes e.g. the substances included in the EEC-list of priority chemicals (list 1, Directive 76/464/EEC) like pentachlorophenol, vinylchlorid, xylene etc.

B: Substances that can be accepted in certain concentrations and hence should be reduced by all means which are technically and economically achievable for the industries. This group includes most heavy metals and the principle goes for a number of sum parameters, too.

C: Substances that can be treated - read decomposed - by the treatment plants and hence can be regulated basically by the mechanisms of waste reduction and resource conservation. Examples are acetone, ethanol, etc.

This has proven to be an easily understandable system, also because it corresponds to the BAT/BATNEEC concept, since group A substances should be reduced by BAT while group B substances should be reduced by BATNEEC.

Of course the basic information as to which category the individual substances belong, must be available and this has turned out to be - to some extent - a practical barrier for the implementation of the concept, since the development of the lists is very resource consuming and needs specialist in-put. Naturally this approach also has to be adapted to products composed of several substances and for this reason a set of criteria for composite products has been developed (but not yet officially adopted).

ENVIRONMENTAL STRATEGY

Development of standards or guidelines requires a clear and consistent environmental strategy in order to be able to adopt a set of assessment criteria for the aspects to be considered. In relation to discharge of industrial wastewater to public treatment plants it has to be decided whether the basic approach is; 'mixing of everything and solving the problems in the end' or 'source control and separate treatment of the individual waste streams'. Naturally only the last strategy will be sustainable in the long view but this is often difficult to realise, particularly in areas where sludge is incinerated or brought to landfill. In these situations the decision-makers seem to forget the recipient for treated water or feel convinced that the treatment plant will solve all problems.

Studies on fate of heavy metals in the Danish treatment plants with nutrient removal, shows that some of the heavy metals will only be transferred to the sludge to a minor degree - see Figure 3 (adopted from Grüttner and Jacobsen, 1994), and in the same way it was found that a number of specific organic substances did pass the treatment plant in significant amounts.

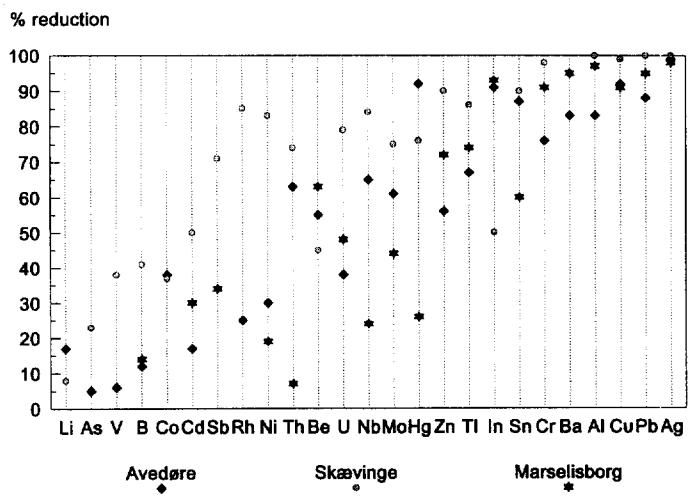

Figure 3. Average precipitation of heavy metals and other elements in three Danish treatment plants.

For these reasons the Danish EPA adopted the following strategy for development of 'Guidelines for regulation discharge of industrial wastewater to public treatment plants':

- That the treatment plant is to be considered as a production plant producing treated water of the best achievable quality and a sludge product applicable for use as fertiliser in agriculture.

- That all wastewater discharged to the sewer network should - in principle - be of a character that makes it possible to treat it in the most common type of treatment plants (which is biological treatment plants with biological nitrogen removal and chemical phosphorus removal).

The last principle implies that dilution in the sewer network is not taken into consideration in the criteria for determining the recommended effluent standards for group B substances, e.g. the heavy metals.

These basic principles make it possible to use some very simple and consistent criteria for the assessment of the substances to be found in the wastewater (as described by Grüttner *et al.*, 1994), but naturally this approach will not be in operation over night. Actually it is expected that the implementation of these principles will last for many years and will demand a significant input of resources by the authorities and the industries. On the other hand experience with the Guidelines has shown that in particular the above clear signals are important for the authorities in the dialogue with the industries (according to personal communications with a number of case officers in the local authorities around Copenhagen).

Combination of environmental and technological considerations

One of the key problems in all environmental regulation is how to combine the technologically based considerations with the environmentally based considerations, and evidently this applies for discharge of wastewater in particular.

An example of such a conflict has been discussed in Denmark for the recent years in relation to electroplating industries. For this branch of industries the PARCOM-recommendations (PARCOM, 1992) present guidelines for the generally achievable level of concentration for heavy metals etc. in the effluent, and at the same time the Guidelines from DEPA give a similar set of concentrations - see Table 1.

Table 1. Recommended maximum concentrations in effluent from electroplating industries according to the PARCOM-recommendation and the Danish EPA Guidelines (mg/l)

Parameter	PARCOM-recommendation	DEPA guidelines
Silver	100	250
Cadmium	200	3
Chromium (total)	500	300
Chromium (VI)	100	-*
Copper	500	500
Mercury	5	3
Nickel	500	250
Lead	500	100
Tin	2000	-*
Zinc	500[1]	3000
Cyanide	200[2]	1000[3]
Volatile organic halogens (VOX)	100	-*

Notes:
* For these parameters the no environmental assessment have been made in the DEPA guidelines
1 Only in certain situations can 2000 mg/l be accepted
2 Free cyanide
3 Total cyanide.

From the table it can be seen that for silver, zinc and cyanide the environmental considerations (as assessed in the DEPA guidelines) are fulfilled by the PARCOM recommendations, and for chromium, mercury, nickel and lead the recommendations and the guidelines are at the same order of magnitude, while for cadmium a significant conflict exists. For chromium (VI), tin and volatile organic halogens the DEPA guidelines have not assessed the environmental effects.

This of course gives rise to the question among the industries and the authorities from which set of values the individual permit should be developed. To answer that question it is necessary to realise that the recommendations given by the PARCOM are fixed based on technological considerations while the DEPA guidelines are based purely on environmental considerations. Hence the DEPA guidelines determine the environmentally acceptable level - but the guidelines do not determine when this level should be achieved.

This means that for a short time consideration the technologically based recommendation can be used, if an environmental assessment in the individual situation justifies that e.g. the high cadmium concentration will not have unacceptable environmental effects. In the longer perspective the industries will have to realise that this level is not environmentally acceptable and hence they will have to work further to find a way for continuous improvements.

Expression of demands

Finally a discussion among 'regulators' concerns how to express the demands - whether dealing with general standards/guidelines or individual permits. Should these values be expressed as concentrations or amounts - or maybe as specific production related key-factors?

Basically it has to be realised that demands and control are very closely related, since all demands should be controllable. In addition it needs to be possible to conduct the control in a way that does not use excessive personnel and economic resources.

Further it has to be realised that the above mentioned possibilities relate to the way the individual demand is developed. Demands developed on the basis of environmental considerations are normally developed as concentrations - or to some extent as amounts - and hence it is very difficult to transfer these values directly to production related key-factors.

The opposite situation occurs for technologically based figures that very often are created as production related key-factors. Examples of functional units for production related key-factors are shown in Table 2.

Table 2. Possible functional units for a number of industries

Type of industry	Possible functional units
Printing industry	Area of paper
Dairies	Consumption of milk
Abattoirs	Consumption (number) of animals
Textile dyeing	Weight of cloth
Electroplating	Consumption of electrodes
Tanning industry	Consumption of hides

Using production related key-factors when setting demands has the advantage that such figures are easy to understand for the people in the industry and makes it possible to create a control-system that relates to the size of the production. Further such 'emission-factors' may be used for other purposes like environmental reporting and 'bench-marking' among the industries themselves. Naturally the production related key-factors have to be evaluated against the environmental considerations, and hence the relation between the two different measures has to be described in the permit.

When a pretreatment facility is in operation, an exception to the above mentioned technological approach exists, since in these situations the process involved will often reduce the compounds to a certain level of concentration.

The use of 'amounts' per time unit generally is useful in relation to 'load-considerations' on the central treatment plant or the receiving water, which means that this measure in particular applies for components which can be handled up till a certain amount e.g. organic matter and nutrients.

In the regulation of industrial wastewater all three methods may be applied for expressing the demands, but it is important always to describe how they are related to the measure of environmental concern.

The relative importance of the different ways to express the requirements in relation to environmental and technological considerations are summarised in Table 3.

Table 3. Illustration of the relative importance of the different ways to express the requirements in relation to environmental and technological considerations

Measure of concern	Environmental considerations	Technological considerations
Concentrations	**	*
Amounts	*	*
Production related key-factors		**

CONCLUSIONS

As expressed above guidelines/standards for industrial wastewater discharged to public wastewater treatment plants are needed for many purposes. When determining the regulatory framework for this area the following aspects must be kept in mind.

In order to stimulate pollution prevention it is important to select a consistent environmental strategy that makes it possible to express environmental priorities in a simple and easily understandable way.

To realise the potential of pollution prevention the use of permits with individual requirements is probably the optimal solution, but at the same time this approach is very resource consuming.

It is important to consider very carefully how the requirements are enforced in order to make it possible for the industries to solve the problems with pollution prevention and cleaner technology and not by end of line technologies.

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